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## MANUAL OF X-RAY MANIPULATION.

BY

W. J. MORTON, M. D.

CONTENTS: Description of Coils and Machines, of Tubes and Methods.  
100 Illustrations.

PRICE 75 CENTS. POSTPAID 85 CENTS.

*Third Edition.*

# APPARATUS AND METHODS

FOR PRACTICAL USE

OF

# X-RAYS.



L. E. KNOTT APPARATUS COMPANY,

Incorporated under the laws of Mass.

Microscopic, Chemical and Physical Apparatus.

Photometers and Chemicals.

SPECIALTY: The National Physics Apparatus.

14 ASHBURTON PLACE,

BOSTON.



## INTRODUCTION.

Of all discoveries in the history of science, no other has attracted such interest in the popular and scientific mind as that gradually developed since the announcement of Professor Roentgen. The intensity of this interest is all the more astonishing when we consider that only a few months have elapsed since the results of his investigation were made known.

Although repeated experiments had demonstrated the presence and nature of the cathode ray, it remained for the Wurtzburg professor to prove the existence and power of the unknown, or X ray. The astonishing claims incident to this discovery were received throughout the civilized world with incredulity and amusement; and even since the confirmation of these claims, the importance of them has been only in a measure appreciated. The interest thus early aroused has been the cause of enormous strides in the perfecting of apparatus and in the development of methods of application of this new force.

### History.

Seldom do practical results substantiate the claims made by the original promoters; but in the present discovery the modest claims made by Professor Roentgen were, even after the first few weeks, more than realized by American investigators. In these first experiments, it was thought possible to photograph only the hand or other equally thin portions of the body, showing the bones with varying degrees of clearness; but today there is no bone of the human body that has not been photographed successfully, and even examined directly with the fluoroscope. Indeed, the field of usefulness is being so rapidly extended that it is hardly possible to make definite statements concerning the work which is now being done. We do, however, know of much successful work of diagnosing cases of cancer, tumor, apendicitis, and gall-stones, in addition to the more common cases of fracture and the locating of foreign bodies.

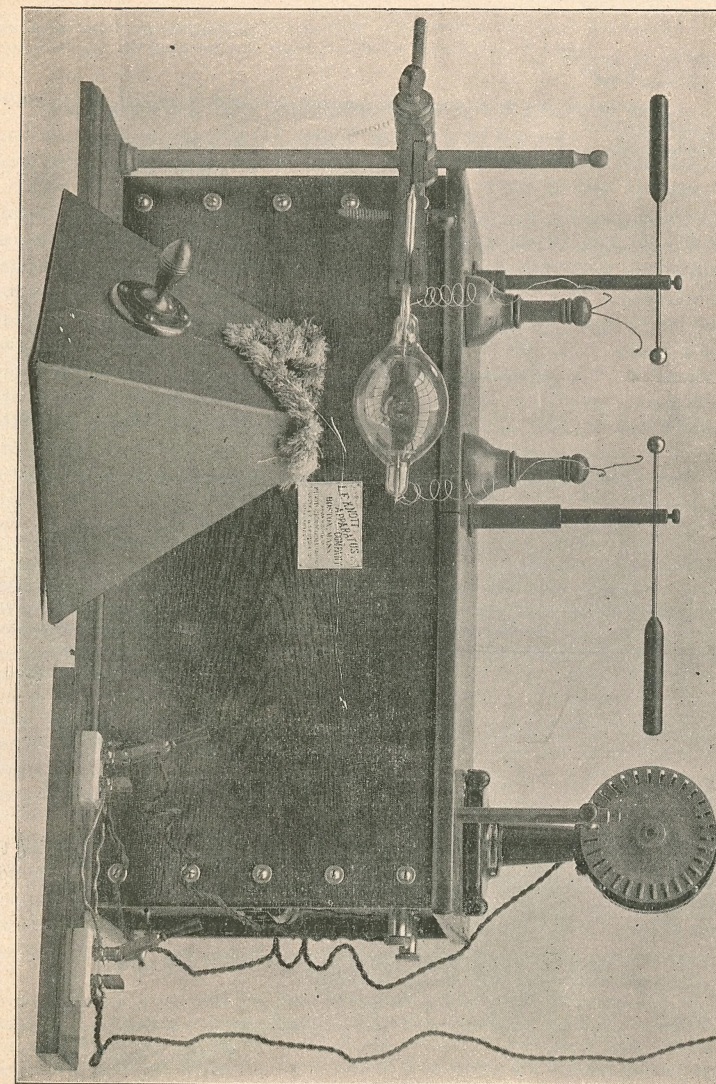
This diagnosis is obtained by allowing the screen to be brought to such a point in the fluorescence that slight indications of the result looked for are noticed. At this point, the current is instantly cut off, then the current is again turned on, and the fluorescence brought to the same point. The operation is repeated until a vivid impression of the results looked for is made on the mind. The remarkable results obtained might seem startling were it not for the ingenious method employed, a more complete description of which will be found on page.

### Applications

One of the most unlooked for applications has recently been developed in the field of dentistry; and, certainly, no profession has been more ready to grasp the benefits to be derived from this discovery.

### Dentistry.

Already much excellent work has been done and no little attention given to the devising of special instruments for dentistry. Those who are not already acquainted with the work of Dr. W. Rollins, of Boston will be much interested in some of his methods for using X rays in his practice. By the aid of a small silver fluoroscope, with a reflecting mirror, he is enabled to make careful examinations of the roots, cavities, nerve-channels, etc. Also by photographic process, he gets results showing remarkable definition of the enamel, dentine, cementum, and nerves. Fine distinctions are obtained by using a large number of sensitive films



L. E. KNOTT APPARATUS COMPANY'S ALTERNATING, HIGH FREQUENCY COIL  
No. 800.



superimposed. These films are exposed in a small silver plate-holder, so adjusted as to be inserted in any portion of the mouth. The value of such results must be apparent to every dental surgeon.

The excellent work done by Dr. Kells, of New Orleans, has already been brought before the public.

124 BARONNE ST., NEW ORLEANS.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

I am charmed with the Roentgen Ray apparatus, received from you, and with the results already obtained with it.

I have succeeded in taking fine skiagraphs of the roots of the teeth in living subjects.

Yours truly, C. EDMUND KELLS, JR., D. D. S.

Hospital

In hospital work and in the private practice of progressive surgeons the use of the X ray apparatus is now indispensable. This fact was forcibly brought to our notice not long since by the receipt of a negative showing a fracture of several weeks standing. This fracture was supposed to have been properly set, and the patient nearly ready to be discharged. Through a plaster of Paris bandage around a man's thigh, the X Ray negative was made of the femour, which had been fractured. The negative showed that it was an oblique fracture and that the upper fragment had slipped over the other. The attempt to set the fracture did not bring it into apposition. A fluoroscopic examination, or a negative taken, from time to time, would have shown whether the bones had been displaced, and to what extent they had united, making it unnecessary to remove plaster of Paris casts.

URBANA, OHIO, Aug., 8, 1896.

MESSRS. L. E. KNOTT APPARATUS CO.

Gentlemen: — Your high frequency coil for alternating circuit is giving very satisfactory results in the Roentgen experiments. Our Medical Association has expressed its highest appreciation of the working and results of the Coil. I am safe in saying that my experiments have verified your high claims of its efficiency.

Very truly,  
I. N. KEYSER,  
Prin. Urbana High School.

Those who have watched the progress of the work are already familiar with the great variety of operations which have been made possible: careful examination of fractures of almost every bone in the body; locating of bullets, fragments of glass, and other foreign substances; these and other similar cases have already ceased to attract attention.

In the progress of the work, however, new cases are constantly coming to notice; as, for instance, the successful photographing of the skull by Professor Bumpus of Brown University, a full account of which appeared in the Providence Journal of recent date. In this operation, it was found that five minutes produced a very satisfactory negative, in which the course of a bullet, with which the patient had been accidentally shot, was clearly indicated.

THE CATHOLIC UNIVERSITY OF AMERICA,  
WASHINGTON, D. C.

The coil has operated in a satisfactory manner, both with alternating and direct current.

Yours truly,

DANIEL W. SHEA, Prof. of Physics.

Emergency

The value of the instrument in the Emergency Wards of Hospitals can hardly be over estimated. From a published classified list of cases covering a period of

one year in the work of a single hospital in this city it was recently estimated by a Physician that an X ray outfit, such as we are now furnishing, would have been of great value in over 3000 cases.

RHODE ISLAND HOSPITAL,  
PROVIDENCE, R. I.

I am very much pleased with the apparatus. The first time the current was turned on, it gave a beautiful light, and has given good satisfaction during several hours of work.

H. C. BUMBUS, Ph. D.

We are pleased to note also that progress is being made in the use of the apparatus so as to obtain good results with shorter exposure. Indeed it is now found that for certain fine effects of detail a short exposure is often more desirable.

This has been clearly shown by Dr. Strong of the Boston Homœopathic Hospital. In his work the Tesla Coil was used and two seconds found to give the very finest detail of ordinary objects while the most satisfactory shadow-graph of the hand which we have yet seen was produced by a practically instantaneous exposure.

Progress.

From a Utica, N. Y. daily of July 31, we take the following:—

#### X RAYS AT FAXTON HOSPITAL.

SUCCESSFUL EXPERIMENTS CONDUCTED UNDER THE DIRECTION OF  
REV. J. W. WHITFIELD.

Some two or three weeks ago, the tesla coil, manufactured by the L. E. Knott Company of Boston, arrived at Faxton Hospital. It had been seen working by Dr. Glass of this city, at the medical society meeting in Boston, and ordered by him for use in Faxton Hospital, as he was much delighted with the experiments given there. Since its installment at the hospital, Rev. J. W. Whitfield has been experimenting with it, in producing X ray photographs. He has succeeded in a marked degree in reducing the time of development, as well as the exposure. Fifteen minutes to an hour has been the usual time of exposure, while the picture afterward has taken from one to three hours, in the hands of most manipulators. Mr. Whitfield exposes a plate without any tungstate of calcium screen, and obtains a picture in five minutes at the longest, and succeeds equally well with one or two minutes exposure and two or three minutes development. With longer development the exposure could be reduced to a small fraction of a minute, and a well defined copy of the subject be obtained.

In the interests of the patient it is pleasing to note that by means of improved apparatus it is possible not only to alleviate, but in many cases to prevent suffering. After an operation for fracture or dislocation, the physician is now able to examine the condition without removing the splints or bandages, thus saving the pain occasioned by handling the parts. In such cases there should never occur improper setting from improper diagnosis.

Bullets, needles, etc., have in the past often evaded the most skilful surgeon, where now foreign bodies can be located at once without the use of the probe.

#### APPARENT EFFECT ON BACILLI AND DISEASED TISSUE.

With reference to the tubercular cases treated, am glad to say that the movement in the elbow case has increased from about fifteen degrees until now he has something over ninety degrees latitude of motion. Understand me that the ankylosis was not bony, but was due to soft inflammatory changes with the exudate thrown out, characteristic of these cases. The heat and swelling tension, in fact all of the symptoms of the malady, have practically subsided.

The case of ganglion or bursal trouble of the wrist continues to improve, the patient being able to extend the finger almost completely, with a subsidence also of the inflammatory symptoms which existed. The diagnosis in either case is not proven; we assume it, however, to be correct, as nearly all bursal enlargements of the wrist of this character are found to be tubercular in origin. The elbow joint also gives characteristic natural history of tubercular disease.

Very truly,

J. H. GLASS, M.D., Faxton Hospital.



Not long after the announcement of Professor Roentgen's discovery, laymen began to realize that a new and extremely interesting field of science had been opened up. Nor has the interest in its possibilities lessened. On the contrary, the public continues to show a legitimate curiosity in this most humane of sciences. The insatiable desire of the American people, to be well informed on all matters of scientific importance has led to the establishing of exhibitions and to the giving of lectures for their enlightenment. The desire of exhibitors to take advantage of this interest has induced them to undertake the work with cheap and inefficient instruments.

Exhibition.

The public, however, are not now satisfied with the extremely poor results which these cheap instruments give, and are already demanding genuine, scientific presentation. Wherever the Tesla Coil has been used, the interest is found to increase as the public become more and more familiar with the results.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—I have been so much pleased by the result of my experiments with X Rays from your Tesla Coil and Reflector Tubes that I am sure you will be interested in them.

I have used the apparatus both in private experimenting and in public lectures, and have thus far had perfect pictures with every exposure.

I have secured sharp negatives of articles through vulcanite plate holders in less than five seconds, and this result, too, without the aid of a fluorescent screen or even heating the platinum of the tube.

In three minute exposure, under the same conditions of tube and plate, the Rays gave a sharp negative after piercing nine inches solid spruce timber and the vulcanite plate holder slide.

I have also made duplicate negatives by using a double plate holder, the Rays penetrating one glass plate and affecting the next; time, five seconds.

I know of no apparatus so well adapted for lecture purposes. In a darkened room, by means of a hoodless fluorescent screen, I have been able to show the whole audience the outline of my hand, even to distinction of flesh and bones.

To convince people of the genuineness of X Rays, I make pictures in their presence of articles given me by the audience, placing these sometimes under several books or some inches of wood. Usually I take the negative of a person's hand. These negatives are developed at once and given to the audience for inspection. There is no other apparatus by which these results can be secured so forcibly and without a moment's delay.

Yours truly,

CHESTER B. CURTIS, M.L.

In addition to showing the bones of the skeleton, the changing outline of the heart, and other phenomena directly related to the X ray work, the entire subject of the Tesla high frequency and high voltage currents is of the most absorbing interest.

OHIO WESLEYAN UNIVERSITY,  
DELAWARE, OHIO.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—The Tesla coil which you made for me has given perfect satisfaction. I consider it superior to a Rhumkoff coil. With it I have reproduced many of Tesla's interesting experiments. As a means of exciting a Crookes tube I have found nothing equal to it.

Your focus tubes for alternating currents have reduced the time of exposure for radiographs to a very few minutes. I am well pleased also with your fluoroscope.

Sincerely,

WILL G. HORMELL.

With the cheaper form of apparatus this entire field must be overlooked, but with our improved instrument the exhibitor, the lecturer, or the instructor has within his reach not only the means of showing the most powerful results of the X ray, but also the phenomena involved in the extremely interesting researches of Crookes, Hertz, Lenard, Thompson, and Tesla.

The Tesla Phenomena is most interestingly described in Mr. Tesla's little book on High Frequency and High Voltage Currents, also in his other researches about to be published.

These may be obtained from Wm. Johnson & Co., New York.

The early experimenters in X ray photography were forced to use apparatus designed for the study of the cathode ray, the older form of Crookes tubes being excited by the induction coil or some form of the static machine.

We feel that it will be of interest to our patrons to consider briefly the development of the present efficient apparatus.

You will recall that on January 7th, the news of Professor Roentgen's discovery was first cabled to this country. Believing in the value of the results already obtained, we immediately applied ourselves to the designing of Crookes tubes especially adapted for the production of X rays. Little progress was made until after twenty days of incessant labor. On January 27th, however, we succeeded in making a tube which we believe to be in advance of anything before attained. Every improvement in the tube suggesting greater possibilities we soon were induced to enter upon a more elaborate series of experiments involving not only the tube itself but also the methods of exciting it. Thus investigations soon proved clearly that the intensity of the ray effect depends more upon the character of the discharge used to excite the tube than upon the tube itself. The good results occasionally obtained with either the induction coil or the static machine led us for a time to confine our attention to the tube. The limitations, however, of these instruments as means of excitation were soon apparent. In the static machine the frequency of discharge was of necessity too low to produce powerful fluorescence. In the induction coil the same difficulty was encountered, with the addition of too great a volume of current, producing an unnecessary amount of heating in the electrodes.

Office of  
DRS. G. R. & G. C. SKINNER,  
310 Second Avenue.

CEDAR RAPIDS, IOWA.

The Tesla coil is giving good satisfaction and we are making some fine pictures.

Sincerely yours,

G. R. SKINNER.

The problem then presented itself of producing some method of exciting the tube, which should consist in extremely rapid discharges of high voltage currents, in which the amperage should be so low as to produce only a slight heating effect.

At a recent meeting of the British Association, Dr. Trouton read a paper on "The Duration of X-Radiation at Each Spark." He found the duration to be sometimes only  $\frac{1}{10000}$  of a second, sometimes as long as  $\frac{1}{800}$  of a second. Prof. J. J. Thompson remarked that radiation so brief showed how inefficient was a spark coil as an instrument for producing it, since the period of the spark was so much longer than the period of the radiation.—*Electrical Engineer*, Oct. 21, 1896.

Being attracted by the account of the results obtained by Nikola Tesla, our attention was naturally turned in the same direction. Knowing the importance and difficulty of the problem we had set out to solve, we at once placed the matter in the hands of one of the most efficient corps of electrical experts in this country. After weeks of careful experimenting, we were able to obtain the results which many of the more progressive experimentors had been demanding. The formula for the instrument thus devised we believe to be the best possible, namely, such as to produce high frequency and high voltage with low amperage. With a consumption of  $4\frac{1}{2}$  amperes at 52 volts, we are able to obtain a voltage of about 2,500,000,

High Fre-  
quency Coil.

Apparatus.



with a frequency of approximately 400,000. The effect of this discharge on the Crookes tube can be readily imagined.

ST. LOUIS, July 17, 1896.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—Please advise me by return mail what price you can make us on a complete X ray outfit, exactly like the one you furnished Dr. Heber Roberts of this city. Also one reflector Crookes tube and fluoroscope, 8 x 10. The writer set up and has been operating this outfit for Dr. Roberts since its arrival, and is more than pleased with the results.

Very truly yours,

WESTERN ELECTRICAL SUPPLY CO.

Discharger.

With the regular form of Tesla Coil, in which the discharge of the condenser depended upon the magnetic or air blast blow-out, it was found impossible to produce a uniform discharge. This difficulty has been entirely overcome by our patent mechanical discharge shown in the cut. With it the operator is able to regulate the potential of the discharge and to produce a uniform fluorescence in the tube.

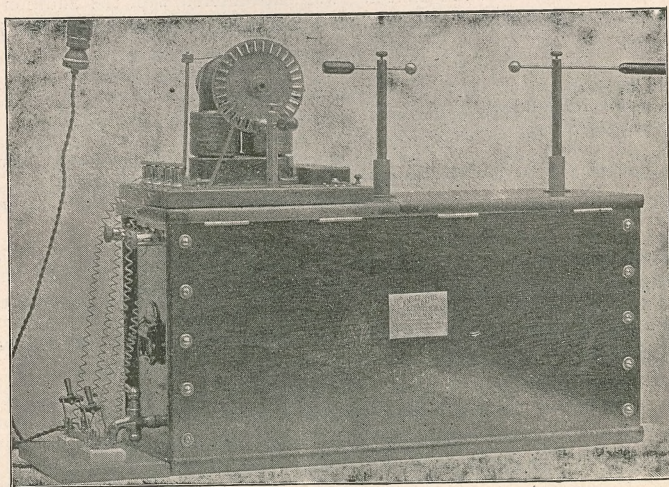
WASHINGTON & LEE UNIVERSITY,  
LEXINGTON, VIRGINIA.

The coil continues to work finely.

Yours truly,

S. T. Moreland.

This entire instrument is contained in a handsome French polished oak case with nickel plated trimmings. The general form of it is shown in the accompanying cut.



L. E. KNOTT APPARATUS COMPANY'S, SPECIAL, DIRECT CURRENT, HIGH FREQUENCY COIL, NO. 801.

Current.

We are now making the instrument in two designs, one to be operated from the direct, and the other the alternating incandescent system. The first can be operated on any voltage from 50 to 110; the second on either a 52 or 104 volt circuit.

Reliability.

As the time and unavoidable annoyance in using the older instruments has been a great barrier to their introduction for practical work, we have endeavored to reduce the labor of manipulation to the last possible degree. In accomplish-

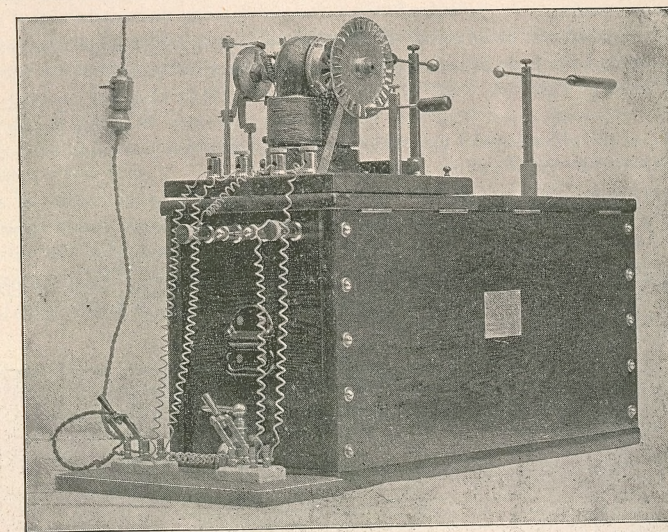
ing this object, we have so far succeeded that there is absolutely no time required in putting the machine into operation, the entire instrument being controlled by two simple switches.

In hospital and lecture work, it is of the utmost importance that the instrument can at all times be relied upon. This advantage we have secured by simplifying the construction to the last degree.

No change in the atmospheric conditions can in any way effect its successful operation.

Of no less importance is its durability. To this point we have given great attention, and each instrument is subjected to long and severe tests before being sent from our factory.

When a neat, convenient, and reliable instrument is desired, one that will give a steady, uniform, and powerful fluorescence, we feel confident that there is no



L. E. KNOTT APPARATUS COMPANY'S, SPECIAL, DIRECT CURRENT, HIGH FREQUENCY COIL, NO. 801.

instrument on the market which can in any way compare with our High Frequency Coil.

Since the issue of our last circular the still further perfecting of the Crookes Tube has received the most earnest and persistent attention of our glass department. In developing the various forms which we are now making, we are indebted not less to our many friends than to our own efforts.

The present high efficiency of the tube has been obtained by careful study not only of the form and size, but also of the form and position of the electrodes, combined with the careful regulation of the vacuum.

The question of the durability of the tube is one that is often asked. As this depends entirely upon the exercise of proper care, it is difficult to make definite reply. We do, however, know of one tube having been used in this city to exhibit X ray effects to over 12,000 people.

We manufacture the various forms of the tube here mentioned, and keep them constantly in stock.

Tubes.



### Form of Tube — Double Reflector Type.

For High  
Frequency  
Coils.

Since the experience of very careful investigators leads to the conclusion that the extremely rapid discharge is necessary for the best results, we have endeavored to produce a tube especially adapted to the rapid oscillation and high potential obtained in the High Frequency Coil. Through our own experiments, combined with many valuable suggestions, we are now able to furnish a tube which will not only withstand a current of enormous frequency and potential, but also combines the great additional advantage of causing the rays excited by both electrodes to pass through a single point of the glass. The clearness of definition thus obtained renders this form extremely valuable for exact scientific work.

This tube when properly excited cannot be exceeded for speed and penetration.

### New Adjustable Vacuum Tube.

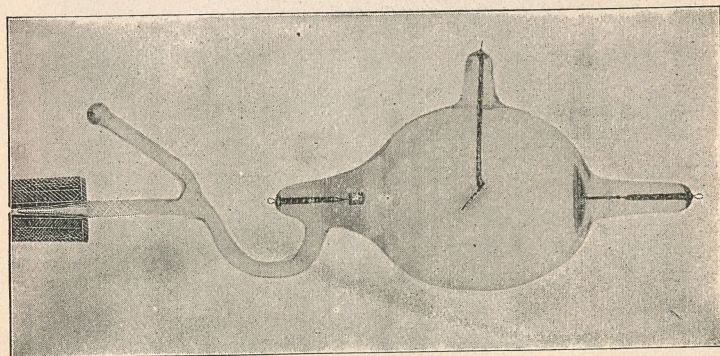
*The New Adjustable-Vacuum tube maintains a constant vacuum and insures much better results.*

The question of maintaining a constant vacuum has been most perplexing. Manufacturers have been forced to admit that with long continued use the vacuum would become so high that little or no discharge could be obtained through the tube. To overcome this difficulty it seemed only necessary to apply the method employed in the older form of Crookes tubes. This however proved to be entirely inadequate for the requirements of X ray work.

After much experimenting we have at last devised a combination of salts which will volatilize at the right tension and pressure to insure uniform results.

We have also succeeded in so balancing the various parts that the vacuum can be readily adjusted to either high or low voltage currents. The advantage of this will be readily realized by those who have had experience in X ray work.

Full directions for use with every tube.



NEW ADJUSTABLE VACUUM TUBE NO. 803.

MAINE EYE AND EAR INFIRMARY BUILDING.  
PORTLAND, ME.,

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—I enclose you a print of a screen which I laid under boards which were one inch thick. The first two boards laid on top of the screen were seven inches long, and the next two a little shorter, and so on, until the pile was ten inches thick. The tube was placed in such a manner that it would have to penetrate the entire thickness of ten inches in order to effect the plate under the thickest part. I made this experiment to see what thickness of wood I would

be able to penetrate in two minutes, also to try your alternating current tube which you sent me last week. I consider this the best out of seven different styles of tubes from four different manufacturers.

Very respectfully yours, H. E. MURDOCK.

### Single Reflector Tube.

This tube is the outcome of experiments recently published in England. It gives the finest results of anything that has been known. It is made especially for use on a Rhumkoff coil excited by a direct current. We believe that Prof. A. W. Goodspeed, of the University of Pennsylvania, was the first person in this country to photograph through the body with this tube, and his work on the subject has been extremely valuable. Work done with it has the greatest definition and results are obtained in an exceedingly short time.

We manufacture this tube in two sizes for adaptation to various conditions. The larger is made for Rhumkoff coils giving a spark of 5 or more inches. The smaller is made for a coil giving from 2 to a 5 inch spark.

This tube operated by any of the large medical electrical machines, will show the bones of the body clearly.

GAINESVILLE, TEXAS, Aug., 7, 1896.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—The tube you sent me is the best I have ever tried. I can always speak highly of your tubes.

Yours truly,

CHARLES A. CANNON.

DENVER, COLO., July 16, 1896.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

*Gentlemen:*—We have been using, for some time, the tube you sent us and find it by all odds the best one we have had. It gives very clear pictures with great accuracy of detail and operates cooler than any other tube.

Very truly yours, THE MOUNTAIN ELECTRIC CO.

UNIVERSITY OF PENNSYLVANIA, DEPARTMENT OF PHYSICS.

L. E. KNOTT APPARATUS CO.

*Gentlemen:*—The large tube you made for me a couple of weeks ago is a beautiful one. It shows clearly through two people superimposed.

Hastily,

ARTHUR W. GOODSPEED.

OHIO STATE UNIVERSITY COLUMBUS, OHIO, April 25, 1896.

L. E. KNOTT APPARATUS CO.

*Gentlemen:*—The Crookes Tube received from you gives excellent satisfaction. Enclosed please find \$6.00 for which send me another one same as one before for "3" spark.

Yours truly,

ERNEST BRADFORD.

LOWELL HIGH SCHOOL, LOWELL, MASS.,

L. E. KNOTT APPARATUS CO.,

*Gentlemen:*—I wish to state that the last Crookes Tube is the most efficient and most satisfactory tube that I have used.

Very truly yours,

CYRUS W. IRISH.

HIGH SCHOOL, METHUEN, MASS.

L. E. KNOTT APPARATUS CO.

*Gentlemen:*—Please send to us 4 grammes of Tungstate of Calcium. The tube is a great success.

Very truly,

C. A. PAGE.

### Fluoroscope.

Not the least valuable piece of apparatus for the practical use of the X rays by the surgeon is the fluoroscope. This idea was announced simultaneously by Salvoni of Italy and Prof. Maggie of Princeton. The discovery by Roentgen of the shadow on a fluorescent screen led to the use of this new agent for practical work. It is now generally conceded that tungstate of calcium furnishes the best known screen for fluorescence.

As it has been difficult to obtain a fluoroscope that gives a well defined outline,



we have been forced to experiment in the making of calcium tungstate and in the best method of placing it upon the screen. The results have been so satisfactory that we are now able to obtain a shadow having great detail and definition.

### Our New Non-Phosphorescent Screen.

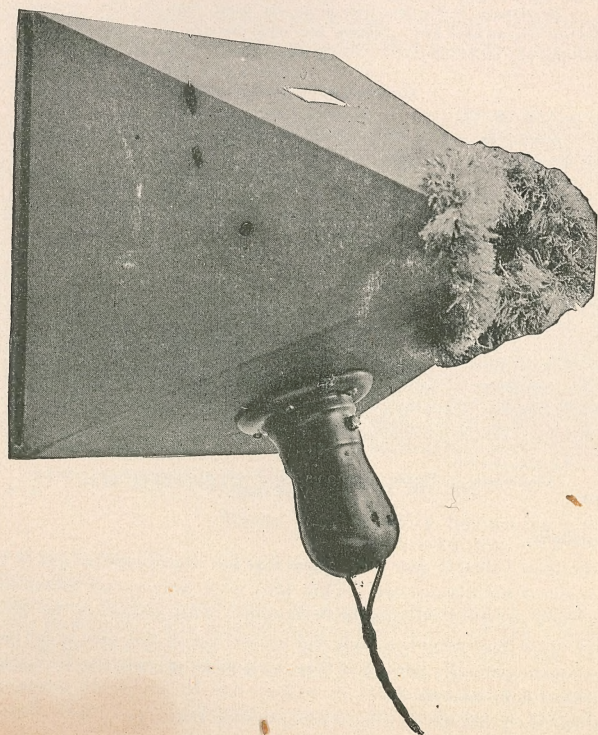
All who have used the fluoroscope containing the calcium tungstate screen have noticed the phosphorescent property of this salt. The lingering of the shadow after the current has been turned off or the part under examination removed is a constant source of annoyance. The lack of a fluoroscopic screen made from a highly fluorescent salt which will both outline and lose its shadow instantly has been strongly felt.

We are now prepared to furnish fluoroscopic screens made from such a salt which we can warrant to work instantly and give perfect definition.

*No phosphorescence from previous exposure to dim the image.*

We are prepared to furnish the very best tungstate of calcium for those who desire to manufacture their own screens and fluoroscopes.

The advantage of a specially prepared photographic screen used in conjunction with a sensitive plate has already been fully discussed in many of the scientific journals. In order to obtain well defined pictures in the shortest possible time, it is necessary that this screen be prepared with great care. After long experimenting we have made a screen having great fluorescent power with a surface so smooth that it produces no discoloration on the film of the plate with which it comes in contact.



FLUOROSCOPE WITH ROBERT'S SWITCH NO. 806.

Several well known operators have experienced difficulty in not being able to cut off the current quickly enough to obtain the best results with the fluoroscope. Through the kind suggestions of Dr. Roberts, we are now furnishing a fluoroscope arranged with an instantaneous cut off, so adjusted that the operator can instantly control the current by simply pressing the button which is on the handle of the fluoroscope.

By means of the cut-off above mentioned excellent fluoroscopic effects may be obtained for examining the softer tissues of the body. To obtain these same results on the photographic plate is of equal importance. Again through the suggestion of Dr. Roberts we are furnishing a fluoroscope so constructed that a photographic film may be inserted directly in front of the screen. Without the use of the plate-holder, this same instrument can be used like any other fluoroscope. For detailed description of its use see Dr. Roberts letter.

L. E. KNOTT APPARATUS CO.,  
Boston, Mass.

ST. LOUIS, Mo.,  
2914 MORGAN ST., Aug., 16, 1896.

*Gentlemen:* — Your appreciative favor relative to my conception of a new device for photographing and fluoroscopic views is read with interest.

Your apparatus for producing speed and detail with the X ray is about perfect. I can take instantaneous pictures of the extremities and view the interior of the body with twenty seconds exposure.

The power of the Roentgen ray is all that is required, but some method of utilizing it to better advantage is demanded.

Photographic pictures as well as fluoroscopic views of the softer structure are essential.

It is impossible to get a good photograph of a tumor, or any consumptive area, or any fleshy induration with any existing device. It also requires much study to differentiate with the fluoroscope diseased from healthy tissue in the interior of the body. This fault lies with the slow method of cutting off the electric current, which should be instantaneous. The cut-off should be under control of the operator, on the fluoroscope, and under the thumb. The picture, consciousness of it, and interception of the current should be, as nearly as possible, simultaneous.

There should be a slide space contained in the outer fluorescent end of the fluoroscope for the purpose of receiving the sensitive plate. A perfect apparatus like yours will readily cast a shadow of the softer tissues followed immediately by transparency, then a shadow of the denser structures progressing in this way until all of the parts are lost. The view wanes before the sight not unlike the mellow receding rays of the northern lights.

With the improved method of cutting off the ray, a picture of the internal structures is readily produced. When such a picture is brought well to view, slide in the sensitive plate, keeping the eyes still in the fluoroscope. When all is ready, turn on the current. The picture will now soon appear on the fluoroscope, and at the same instant on the sensitive plate. This is when loss of time destroys the picture. With some degree of care, combined with the instantaneous cut-off under the operator's control, a perfect picture can be obtained.

Yours truly,

HEBER ROBERTS, M. D.

We furnish with each outfit a complete description of the method of setting up and operating the instrument. This is so simple that no scientific knowledge is required to use it successfully. Simplicity.

In photographing, place the part of which the clearest outline is desired as near to the plate as possible, the tube being located from 12 to 24 inches above the part, with the most fluorescent portion next to the plate. Avoid all movement during exposure. With a little experience the operator will soon learn the time required to produce any desired effect. In hospital work, it is often found convenient to have the entire instrument mounted on a movable stand so that it can readily be wheeled from ward to ward, the current being conducted by a flexible cord. By this means it is possible to use the fluoroscopic or photographic process without disturbing the patient. Photographing.

Valuable hints for the use of the tube may be had by considering the method employed at the City Hospital in Boston. In any examination of the body or lower limbs the patient is placed on a stretcher and brought as near the machine as possible. The tube is supported on a stand similar to Hints.



that shown in the cut on page 3. This stand having a long adjustable clamp, the tube can be placed under the patient and moved in any desirable position while the fluoroscope is placed above the part to be examined.

Use a current of as low quantity and high potential as can be obtained. By so doing the life of the tube will be greatly lengthened.

**N. B.** As high voltage currents have a tendency to short circuit through the glass, hence puncturing it, great care should be taken not to allow the lead wires to come in contact with the glass at any point.

In developing a plate great care should be taken to obtain the required density. A little experimenting in this line will soon show the best method. We may say that the plates should be developed very slowly, and in this manner a proper degree of density may be obtained.

UNIVERSITY OF MINNEAPOLIS, MINN.

L. E. KNOTT APPARATUS Co.,

*Gentlemen:*—Your tube is doing splendid work; I am much pleased with it.

Very truly,

FRED S. JONES.

ALABAMA POLYTECHNIC INSTITUTE, AUBURN, ALA.

L. E. KNOTT APPARATUS Co.,

*Gentlemen:*—I thank you very much for sending me a tube that is far better than any I have worked with. I have a fluoroscope and with it I can see all the bones of the limbs, the spinal column and ribs.

Very truly yours,

A. F. MCKISSICK.

HARVARD COLLEGE, CAMBRIDGE, MASS.

*Gentlemen:*—It gives me great pleasure to testify to the excellent qualities of your various forms of Crookes Tube for the production of X ray photographs. They are well exhausted and will stand high electro-motive forces. I have not seen any better tubes. The specimen of Tungstate of Calcium which you sent me is very satisfactory. I believe that the Tesla Coil is, on the whole, the most satisfactory apparatus for the use of surgeons and in the hospitals. Photographs of the extremities of the human body (adults) can be taken readily in forty-five seconds, and even in less time with a properly proportioned coil. I am glad that you are making such coils for I believe that their reliability, range of adaptation and quick application, will prove their superiority to other forms of exciters of Crookes Tubes.

JOHN TROWBRIDGE.

As no little difficulty has been experienced in producing a good negative from an X ray exposure we have given the matter careful attention and now feel confident in recommending the Curbutt special plate for all X ray work.

These plates are individually wrapped in light-proof wrappers, so that they may be handled in ordinary light and exposed to X ray effect without any plate-holder. The emulsion is such that the X rays are largely absorbed which results

**X Ray Plates.** in shorter exposure.

The best results in developing have been obtained with J. C. Tabloids. With this developer the time is much reduced and good density insured. Complete directions are furnished with each box.

For those who are not familiar with X ray work and desire a thoroughly reliable and definite source of information, we would most cordially recommend the recently published book of Dr. Mortons. Price each 75 cents, postpaid, 85 cents.

**Books.**

The X Ray Apparatus manufactured by the L. E. Knott Apparatus Co., is mechanically and scientifically perfect.

## SURPRISE AT THE MEDICAL SCHOOL.

**Interesting Exhibition of Edison's Fluoroscope Last Night.—Million Volt Current.—Amazing Results are Obtained.**

In this blase generation it takes something very much out of the ordinary to give one a new sensation; but if there is any one thing that will accomplish this result, it is to be able to see the hidden portions of one's own anatomy as plainly as if looking at a class room skeleton. Several persons were afforded the opportunity to do this last evening at the laboratory of the Yale medical school.

Dr. Herbert E. Smith, of the medical school, has been making a number of experiments with the cathode rays and Edison's fluoroscope, and recently purchased an X Ray and fluoroscope apparatus from the L. E. Knott Apparatus Co., of Boston, which he has set up in the laboratory. Last evening, Mr. N. D. Parker, who represents the company, gave an exhibition of the apparatus to a number of ladies and gentlemen who had been invited to witness it.

When the party reached the laboratory they found that a young woman had called with a needle in her foot. The needle had been there several days, and the physicians had been unable to locate it.

Dr. Smith took an X Ray photograph of the foot.

After this matter had been attended to, the party were invited to step into the room where the apparatus was. It was connected with the ordinary street electric light service, one of its advantages being that no storage batteries are needed. The machine contains a Tesla induction coil, which amplifies the 110 volts of the street current until it is increased to something over a million volts. This current is passed through the Crookes tube. The fluoroscope itself consists of a small box, the bottom of which is covered with crystals of tungstate of calcium.

A reporter was asked to sit down in front of the tube and place his face to the fluoroscope. He then placed his hand between the fluoroscope and the tube and the current was turned on. Immediately all the bones of the hand and wrist became visible. They showed up very distinctly, the flesh not obscuring them any more than a slight cloud of smoke would.

The reporter then put his forearm in front of the fluoroscope. The bones of the forearm showed plainly through a coat, a heavy black sweater and the flesh. Mr. Parker then took a rod and passed it up and down behind the reporter's forearm. The rod could be seen as plainly as though the flesh had been made of glass.

Mr. Parker gave an interesting technical description of the apparatus. Another exhibition will be given this evening to which the public is invited.—*The New Haven Daily Palladium* Sept. 26, 1896.

## WITH X RAYS.

**Interesting Experiments Conducted at the Home of Dr. D. H. Murray.**

More wonderful than description are the X-Rays as exemplified by the L. E. Knott machine. To several interested physicians, electrical and newspaper men Mr. N. D. Parker, of Boston, gave some experiments with the Tesla high frequency coil, at the home of Dr. Dwight H. Murray, 426 James St., last evening. With the aid of the Edison fluoroscope the experiments were made very comprehensive. The machine, which takes its current from the ordinary incandescent wire, is intended for surgical work and scientific investigation. Many very successful experiments were conducted, especially with regard to the bones. Other experiments were with coins through 1,500 page volumes, clothing, and so on. One experiment was most practical. A lady who had suffered a dislocation of the ulna without sustaining a fracture of the radius, was brought to Dr. Murray's office and allowed to view the interior of her wrist. The bones had united perfectly, and there was but the slightest line of demarkation where the dislocation had taken place. When the experiment was over she told one of the physicians present that she had felt considerable pain in the wrist of late, and on consulting an out of town doctor, was told that she had sustained a colliis fracture which had been improperly treated. The doctor advised her to begin suit for malpractice immediately. She was about to do so until her mind was changed by her experience.—*Syracuse Daily Journal*, Sept. 3, 1896.

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## PRICE LIST.

These prices are subject to change without notice. All goods will be packed with great care. No responsibility is taken by us for injury in transit. The apparatus is tested before being packed and there should be no failure to operate.

We furnish X Ray apparatus of only the most efficient and finest workmanship.

800. L. E. Knott Apparatus Co.'s High Frequency Coils for alternating current, from 52 to 104 volts, including oil, switches, wires, motor, water resistance and packing case. Delivered to freight or express at Boston. Price, . \$150.00

801. L. E. Knott Apparatus Co.'s High Frequency Coils for direct current, from 50 to 120 volts, including articles as indicated in No. 800. Price, . \$175.00

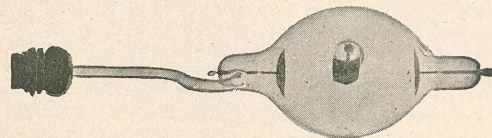
### Crookes Tubes.

We have made many advances in the manufacture of our Crookes Tubes for the most effective X Ray work and they will be found the most powerful and successful tubes manufactured.

#### Suggestions for Ordering Tubes.

When ordering tubes much better results will be realized by giving us all the information at hand concerning the method of exciting, character and length of discharge. If high Frequency or Induction coil be used give kind of current employed, rapidity and character of interruption.

#### Crookes Double Reflector Tube for High Frequency Coils.



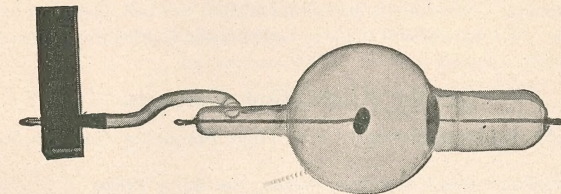
No. 802.

This tube is made of the finest selected glass with thin bulb and perfectly annealed. The workmanship is of the highest quality. All the parts being so perfectly adjusted that we can insure the most effective results. Price, \$10.00

#### Crookes Single Focus Tube for High Frequency Coils.

803. We manufacture a similar tube to No. 802 with a reflector having one point of focus for the rays thereby insuring a finer detail. This tube we claim to give the finest pictures of any tube. Price, . \$10.00

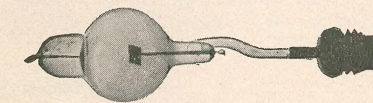
#### Crookes Single Focus Tube for Direct Current.



No. 804.

This model was first manufactured by us for Prof. A. W. Goodspeed of the University of Pennsylvania. It gives the greatest power of anything yet devised for Induction coils of from 8 to 10 inch spark. It has special terminals to prevent puncture. Price, . . . . . \$10.00

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No. 805.

The best tube for a coil giving only a small spark, or for Static machines, etc., is probably the English model. It is especially successful on the Waite & Bartlett, Van Houten & Ten Broeck and other Static medical machines. Price, . \$6.00

### Fluoroscopes.

These fluoroscopes manufactured by us are of the finest material. We have given special attention to definition. The screens are made for durability and practical use. The case is light and convenient.

806. Fluoroscope with Robart's switch in handle, aperture at the back for film. Screen 8 x 10 inches. Price, . . . . .	\$22.00
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We will furnish our non phosphorescent screen with any of our fluoroscopes at an additional price per square inch of screen surface, . . . . . \$0.15

We strongly recommend the large size fluoroscope for practical work as the slightest differentiation of shadows may be more readily detected.

In a small instrument the range is so limited that a comprehensive view cannot be obtained.

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812. Wooden Supports for Crookes tubes, adjustable, illustrated with alternating coil on page 3. Price, . . . . .	\$1.50



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The following combinations are well adapted for use in surgery, lecture or scientific work. We have found them to be the usual combination ordered.

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